

# **A Joint Report on the Progress of U.S.-Japan Fusion Cooperation Program**

(1980[Nov.1979]-2000)

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## **Coordinating Committee on Fusion Energy**

under Agreement

between the Government of Japan and  
the Government of the United States of America  
on Cooperation in Research and Development  
in Energy and Related FieldsRelated Fields

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## **INTRODUCTION**

One of the initiatives developed at the 1978 Carter-Fukuda Summit was bilateral fusion energy research collaboration between Japan and the U.S. In fulfilling this initiative, the U.S. and Japan have been working together closely in all areas of fusion energy science and technology research since November 1979 and have produced high quality results that have contributed to the advancement of fusion energy science and technology. What began as a small set of technical interactions, has evolved into a rather large collection of joint efforts fully encompassing the entire spectrum of fusion energy science and technology. Over these many years, close working relationships have been forged between the Japanese and U.S. officials and technical personnel. International collaboration has been a tool that allows the U.S. and Japan to pool resources to meet their individual fusion program goals in the most effective way. Working with highly qualified people from both countries with different cultures provides the collaborators with an opportunity to solve scientific and technological problems from new and different perspectives, and promotes both collaboration and friendly competition. Consequently, it provides a stimulating environment resulting in a synergistic effect that is good for fusion energy science and technology. It is also good for the people of the world as this international collaboration will contribute to the accomplishment of the common long-term goal of achieving practical fusion energy effectively.

## **FRAMEWORK**

The first Japan-U.S. fusion cooperative activity began with the Exchange of Notes between the U.S. Department of State and Japan's Ministry of Foreign Affairs on August 24, 1979. This exchange established the joint research project using the Doublet-III (DIII-D) tokamak research facility at GA Technologies, Inc., (now General Atomics[GA]) in San Diego, CA. A simultaneous Exchange of Notes also created a joint Japan-U.S. **Coordinating Committee on Fusion Energy (CCFE)** to oversee all cooperative activities. Subsequent Exchanges of Letters between the U.S. and Japanese entities completed the formal framework of cooperation. The CCFE consists of members at the highest levels of the fusion program management in both countries. The CCFE reviews the progress and the balance in cooperative activities and it reviews and formulates proposals for the expansion of cooperative activities. The CCFE is supported by Executive Secretaries from both JA and US who manage the process of developing the annual program of work and prepare the delegation for each annual CCFE meeting.

Individual parts of the bilateral program are overseen directly by Steering Committees, for projects, and Planning Committees, for programs. Steering Committees have been established to manage the projects involving the extended use of a facility in one country in conjunction with the other and they work within the oversight of the CCFE. Planning Committees, both the Fusion Physics Planning Committee and the Fusion Technology Planning Committee, develop programs of coordinated work in their areas of work, bringing together people from the various institutions involved in each sub-area. This framework has evolved as the program has matured.

## DESCRIPTION OF BILATERAL PROGRAM

In November 1979, the annual Program of Cooperation began with 26 exchanges of technical personnel, highlighted by collaboration on the Doublet III facility. In 1988, the Program had grown to 115 exchanges encompassing all fusion areas and involving 300 individuals. Now, after 20 years, the annual Program has grown to nearly 200 exchanges encompassing all areas of fusion energy science and technology. The annual Program of Cooperation involves the Department of Energy (**DOE**) for the U.S., with its laboratory and industrial contractors and its university grantees, and for Japan, the Science and Technology Agency (**STA**) with its technical institutes, principally, the Japan Atomic Energy Research Institute (JAERI), the Ministry of Education, Science, Sports & Culture (**Monbusho**) with its universities, the National Institute for Fusion Science (NIFS), the Ministry of International Trade and Industry (**MITI**) with its laboratory. All parts of the Japanese fusion program, i.e., STA, Monbusho and MITI, come together in the bilateral program. Good working relations and understanding of the different approaches to problem solving in the two countries developed over the past 20 years have enhanced joint work for productive and successful collaborations.

The three basic parts of the Japan-U.S. Fusion Cooperation Program are the joint (physics and technology) planning activities, joint hardware projects, and the Joint Institute for Fusion Theory. Activities in the Program include exchange of scientific and technical information, seminars and meetings, short-term visits to the facilities, exchange and loan of equipment, instruments and material for testing, assignment of scientists, engineers and other experts for extended participation in research, design, planning and experimental activities, and joint projects.

The comprehensive bilateral program covers six project or program areas, e.g., cooperative experiments on DIII-D research facility; many of these interactions involve joint hardware tasks. The continuing interest in these specific activities shows the high degree of commonality of interests between the U.S. and Japan in fusion research. Each of the individual activities in the program is described in Attachment 2.

The following Japanese facilities are currently used in collaborative projects with the U.S.: The **JT-60 Upgrade** experiment, the **JFT-2M** experiment, the **Fusion Neutronics Source (FNS)** facility, and the **Tritium Process Laboratory (TPL)** at JAERI, and the **Large Helical Device (LHD)** at NIFS.

The following U.S. facilities are currently used in collaborative projects with Japan: **DIII-D** experiment at GA, **High Flux Irradiation Reactor (HFIR)** at Oak Ridge National Laboratory (ORNL), the **Advanced Test Reactor (ATR)** at Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho, **Tritium Systems Test Assembly (TSTA)** at Los Alamos National Laboratory (LANL), and the **Tokamak Fusion Test Reactor (TFTR)** at Princeton Plasma Physics Laboratory (PPPL).

## ACHIEVEMENTS

The collaborative activities have increased the effectiveness of current expenditures through joint planning of specific programs, have encouraged the pooling of resources to develop and explore new ideas, have promoted communication between scientists and administrators in both countries, and eventually have contributed to the reinforcement of scientific and technological basis for the realization of fusion energy.

In the physics area, the bilateral cooperation upgraded the Doublet-III facility increasing its value by effectively doubling its capabilities. The results of Doublet III, by both the US and Japanese teams, include a tokamak operation with more than 1 MA plasma current, open divertor configuration, and discovery of remote radiative cooling at the divertor, all of which were the world's first accomplishment. The exploration of a wider range of plasma configurations, world record in the fusion triple product and the important plasma pressure parameter, beta, were also to be noted. JAERI scientific personnel received valuable training and experience in the operation of a large tokamak, Doublet-III, which has benefited Japan's JT-60 operation and experiments, and helped its upgrade to JT-60U with a large D-shaped vacuum vessel, resulting in a tokamak facility with equivalent break-even performance capability. Vigorous Japanese research activities in helical system have been stimulating and beneficial to the planning and implementation of US helical program activities. Experience and insights gained about electron cyclotron heating (ECH) through the use of the U.S. ECH gyrotrons on the JFT-2M tokamak in Japan were important to both programs. In physics theory, the pooling of human resources in the development of the first three-dimensional magnetohydrodynamic models for the non-axisymmetric mirror confinement systems helped scientists in Japan and the U.S. simulate the behavior of important physical phenomena in fusion. . Strong coupling in these fields between the US and Japan should be maintained in the future.

In the technology area, joint collaborations on projects in the materials irradiation area include the technical and financial contributions by Japan to experimental activities on RTNS-II at the Lawrence Livermore National Laboratory (LLNL) (agreement expired) and HFIR/ORR at the Oak Ridge National Laboratory (ORNL), which effectively doubled data output at RTNS-II and substantially expanded experimental information from HFIR/ORR, also from FFTF/MOTA at Hanford site, and from ATR at Idaho National Engineering and Environment Laboratory (INEEL). Furthermore, the U.S. contribution to the Fusion Neutronics Source (FNS) at JAERI, Japan, enabled both countries to predict more accurately the tritium breeding potential of solid lithium compounds. The DOE/JAERI FNS Agreement has expired but collaborative work continues under the IEA Fusion Nuclear Technology (FNT) Agreement.

The upgraded DOE-JAERI Data Link has enhanced and enabled a more effective data exchange than initially available. Scientists at the Princeton Plasma Physics Laboratory (PPPL) and the Los Alamos National Laboratory (LANL) simultaneously participated in JT-60U experiments by remote collaboration. Direct control of the scintillating fiber diagnostic on JT-60U and data analysis were performed from LANL. JT-60U experimental data were remotely analyzed by scientists at PPPL using TRANSP and PEST codes. The DOE-JAERI Data Link has been upgraded to 768K baud to permit further exploration of remote participation technology. This effective and efficient use of remote research collaboration greatly minimizes the travel time and expenses.

Achieving a high degree of technical collaboration on an equitable basis reflects the genuine commitment of both countries to the program's success. As a result of improved communications and the experience of the years of cooperation, program leaders from both Parties have built up a firm basis for discussing more advanced future collaborative activities required to resolve the remaining key issues in fusion energy science and technology.

## MULTILATERAL ACTIVITIES

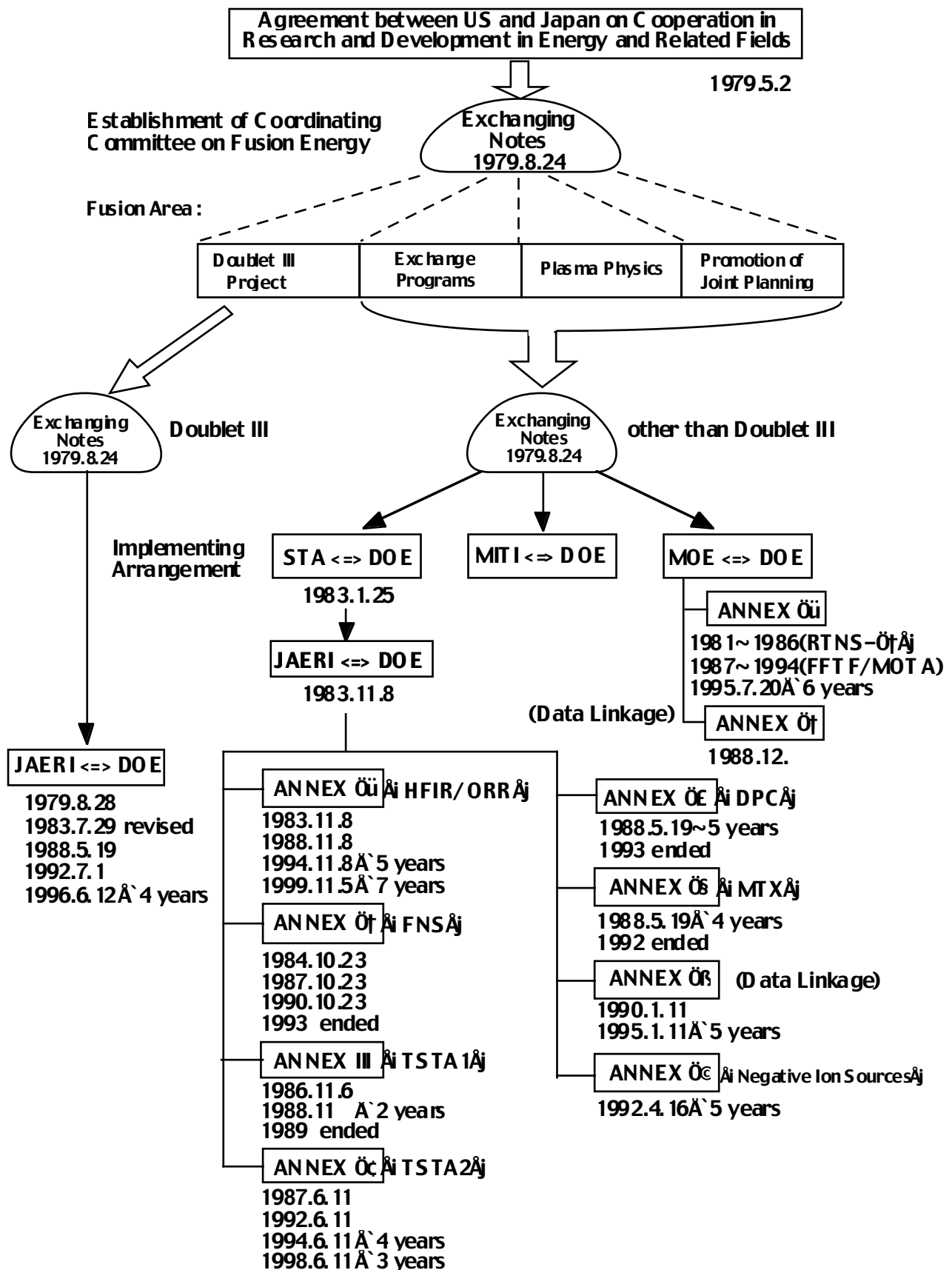
The positive technical experience from the U.S.-Japan Bilateral Program has also served as the basis for multilateral activities. Japan and the U.S. participate together as Contracting Parties in nearly all the **International Energy Agency (IEA) Fusion Implementing Agreements**. In a number of these areas, bilateral work served as a means of strengthening the multilateral work at the outset and, as part of the evolution of the Program, was folded into the multilateral activity for increased economy of effort.

Further, the U.S., Japan, European Community (now the European Union), and the USSR (now the Russian Federation) conducted The Engineering Design Activities for The International Thermonuclear Experimental Reactor (ITER) since 1992. Although the U.S. is no longer a participant, the U.S. and Japan recognize the potential value of the ITER project in developing the scientific basis to promote fusion as a viable energy source.

## FUTURE COLLABORATION

For the future, it is crucial to continue frank discussions for the resolution of the remaining key issues in fusion energy science and technology based on the mutual understanding fostered through 20 years' of collaborative activities, and enhance the collaboration accordingly between the U.S. and Japan.

# US-Japan Fusion Research Collaboration



Current Activities of Fusion Area  
under Agreement between US and Japan  
on Cooperation in Research and Development in Energy and Related Fields

